

## ***Visible and Infrared Investigations of Planet-Crossing Asteroids and Outer Solar System Objects***

Institute for Astronomy, University of Hawaii

**David J. Tholen**

### ***Strategy***

This project is supporting lightcurve photometry, colorimetry, thermal radiometry, and astrometry of selected asteroids. Targets include the planet-crossing population, particularly Earth approachers, which are believed to be the immediate source of terrestrial meteorites, future spacecraft targets, and those objects in the outer belt, primarily the Hilda and Trojan populations, that are dynamically isolated from the main asteroid belt. Goals of this work include the determination of population statistics for the planet-crossing objects, which were poorly sampled in earlier surveys, the characterization of spacecraft targets to assist in encounter planning and subsequent interpretation of the data, a comparison of the collisional evolution of the dynamically isolated Hilda and Trojan populations with the main belt, and the determination of the mechanism driving the activity of the distant object 2060 Chiron.

### ***Progress and Accomplishments***

Earth approaching asteroids that were observed during 1990 include 1951 Lick, 1927 TC, 1989 WM, 1990 DA, 1990 HA, 1990 OA, 1990 SA, 1990 SB, 1990 SM, and 1990 SQ. The most unusual of these objects are 1951 Lick and 1990 SQ, whose colors, based on preliminary reductions, indicate rare A-type and Q-type classifications, respectively. Astrometry was obtained of several of these newly discovered objects to assist in the determination of their orbits. Due to relatively short observational windows for many of these objects, most of these observations were essential to permit future recovery of these asteroids.

During 1990, special attention was given to 951 Gaspra, the asteroid that the Galileo spacecraft will encounter on 1991 October 29. Observations were obtained to characterize this object's rotation state, shape, surface scattering properties, surface variegation, and orbit, all to assist the planning of the encounter and to maximize the science return. The rotational period was found to be just over 7 hours, and the data suggest that the obliquity of the rotation axis is not low. The lightcurve implies a non-symmetric shape, with axis ratios  $a_1:a_2:b:c$  of approximately 1.7:1.5:1.1:1. The phase function could not be uniquely determined due to the changing sub-Earth latitude (and cross-sectional area), but appears to be typical of asteroids with its spectral classification. Very subtle variations in color over the surface may exist, but appear in the data at only the one standard deviation significance level. Six astrometric observations of Gaspra were obtained during the 1990 opposition to help navigate the Galileo spacecraft to the asteroid.

The lightcurves of eight additional Hilda and Trojan asteroids were observed during 1990, thereby augmenting our sample of objects. Analysis of these data are continuing.

Monitoring of the brightness of asteroid-turned-comet 2060 Chiron continued during 1990. The data show a reduced level of activity from the peak in early 1989, but appears to have leveled off, rather than continuing to decrease. Another successful detection of the thermal emission from this object was made at 20 microns, though this time the significance was only at the two standard deviation level.

Portions of the work described here are being done in collaboration with Dr. D. P. Cruikshank of NASA Ames Research Center and Dr. W. K. Hartmann of the Planetary Science Institute.

### ***Publications***

Cruikshank, D. P., D. J. Tholen, W. K. Hartmann, J. F. Bell, and R. H. Brown 1991. Three basaltic Earth-approaching asteroids and the source of the basaltic meteorites. *Icarus* **89**, 1-13.

Hartmann, W. K., and D. J. Tholen 1990. Comet nuclei and Trojan asteroids: A new link and a possible mechanism for comet splittings. *Icarus* **86**, 448-454.

Hartmann, W. K., D. J. Tholen, K. J. Meech, and D. P. Cruikshank 1990. 2060 Chiron: Colorimetry and cometary behavior. *Icarus* **83**, 1-15.

Astrometry of minor planets has been published in the following *Minor Planet Circulars*:

MPC 17522 (1991)	MPC 16669 (1990)
MPC 17492 (1991)	MPC 16331 (1990)
MPC 17105 (1990)	MPC 15967 (1990)
MPC 16956 (1990)	MPC 15948 (1990)
MPC 16801 (1990)	MPC 15810 (1990)

### ***Related Publication***

Schleicher, D. G., R. L. Millis, D. T. Thompson, P. V. Birch, R. Martin, D. J. Tholen, J. R. Piscitelli, N. Lark, and H. B. Hammel 1990. Periodic variations in the activity of comet P/Halley during the 1985/1986 apparition. *Astron. J.* **100**, 896-912.